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Household Preferences and Governance of Water Services

A Hedonic Analysis from Rural Guatemala

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ABSTRACT

This paper estimates hedonic models of rental prices to investigate household preferences regarding water services in rural Guatemala. Estimated values for water services are compared across municipal, private, and community-managed water utilities. Findings indicate that rural households value municipal water services but are indifferent between not having piped water and being connected to a private system. Moreover, the estimated value of community-managed services is negative, which suggests that rural households have an aversion to services managed at the community level. It is argued that the value households assign to water services reflects institutional costs imposed by the forms of service governance here analyzed.

Keywords: water, service governance, household preferences, hedonic analysis, Guatemala

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1. INTRODUCTION

Providing safe drinking water is at the center of current development strategies. In addition to investing significant resources in water infrastructure, several governance reforms have been proposed (for example, decentralization, privatization, concessions, public–private partnerships, and community-based approaches) to improve access to safe drinking water in developing countries. Despite such efforts, access to drinking water is still far from being universal, particularly in rural areas, and existing water systems are often unreliable to provide safe drinking water. Slow progress toward universal provision of water services can be partially attributed to misalignments between service governance reforms and local preferences. Governance reforms have often been established through top-down processes in response to current global trends, ignoring public preferences (for example, see Goetz and Gaventa 2001; Rojas 2000; Sajor and Minh Thu 2009). As the World Bank (1993) and Vásquez, Franceschi, and Van Hecken (2011) have argued, lack of information on household preferences regarding water services is an important impediment to implementing sustainable public water supply systems. Improved understanding of household preferences (that is, the value that households assign to water services) may help identify appropriate forms of service governance in order to implement reliable water projects.

Revealed preference approaches, such as the hedonic price method, are commonly used to estimate the value of publicly provided goods (such as drinking water) and thus provide input for policy and planning purposes (Freeman 2003; Champ, Boyle, and Brown 2003).[1] When applied to housing prices, the hedonic price method makes use of price variations to estimate the value of amenities provided at or near the home (for example, drinking water) under the assumption that housing units are a tied package of separable characteristics (Birol, Karousakis, and Koundouri 2006). A number of recent studies demonstrate that hedonic analysis of housing prices is a viable method to estimate economic values for water services in developing countries (for example, Nauges, Strand, and Walker 2009; Yusuf and Koundouri 2005). However, few hedonic studies have focused on rural communities, and even fewer of them (if any) have compared the value of drinking water across different forms of service management until now.

This paper investigates household preferences regarding water services provided by municipal, private, and community-managed utilities in rural Guatemala. Specifically, hedonic models of rental prices are estimated using data from the 2006 Living Standards Measurement Survey (National Institute of Statistics et al., 2006) in order to derive the value that households assign to municipal, private, and community-managed water services. Given that households may concurrently choose the rental price and the type of water service, rental prices and choices of water service are simultaneously modeled using a maximum simulated likelihood approach. Findings indicate that rural households prefer municipal water services over private and community-managed water provisions. Moreover, findings suggest that there is public resistance to community-managed water systems in rural areas.

To investigate how values assigned to water services may vary across different governance approaches, the next section reviews the theoretical foundations of different forms of service governance (municipal, private, and community management) and presents existing empirical evidence on the performance of utilities under those governance approaches in the developing world. Then, Section 3 overviews the institutional context and current conditions of water services in rural Guatemala. Section 4 introduces the econometric approach used in this study to uncover household preferences for the aforementioned forms of water provision. Section 5 presents the variables used to estimate hedonic models and formulates a set of hypotheses to structure the analysis. Section 6 presents estimation results, and Section 7 concludes the paper with a discussion of the results and some policy implications.

[1] Value estimates are needed when a good or service is not traded in a market setting. In the particular case of water services, estimates are necessary because existing water tariffs do not reflect the value of water provision due to monopolistic practices, public good characteristics, and subsidies given to make water services affordable.

2. WATER SERVICE GOVERNANCE: A LITERATURE REVIEW

A variety of governance approaches have been proposed to increase access to piped water and improve the efficiency of existing water utilities in developing countries. Those proposals include municipal management of water services in a decentralized governance approach, privatization of water utilities, and administration of water services at the community level (for example, see Ahmad et al. 2005; Isham and Kahkonen 2002; and Prasad 2006). In addition to variations in terms of system ownership, these forms of service governance have different incentives and functions within particular institutional arrangements that rule the interaction between water consumers and suppliers, and that may influence the effectiveness of utilities in providing drinking water. This section reviews the theoretical foundations of municipal (or local), private, and community-based governance of water services, and presents empirical evidence on the performance of water utilities administered under those approaches.

Municipal Water Services

Decentralization of operational and managerial functions to lower-level, locally elected governments is often proposed to increase efficiency and equity in providing public services (Ahmad et al. 2005). In theory, decentralization improves the allocation of resources, since local governments know better the needs of their constituents. Due to their proximity to a relatively low number of constituents, local governments tend to have lower transaction costs and more information than the central government, which enables them to be more responsive and efficient, particularly in heterogeneous societies (see Bardhan 2002; Garcia-Valiñas 2007). It has also been argued that local governments have more political incentives to provide improved services given that citizen satisfaction with municipal services may be reflected in the electoral process.

Decentralization, however, has not always improved the efficiency of service providers (see World Bank 2003). In India, Asthana (2003) found that locally managed water utilities were less efficient than state-managed utilities in terms of expense and asset utilization. Anwandter and Ozuna (2002) also reported that the decentralization of water services to the municipal level had not improved the efficiency of water utilities in Mexico. Local governments may lack the technical, financial, and administrative capacity needed to provide public services and manage local resources. Consequently, local governments may provide poorer services than other providers (Bardhan 2002). This is particularly true in developing nations, where human and financial resources are scarce at the local level. For instance, Vásquez (2011) reported that in Guatemala, municipal governments often lack technical and financial capacities needed to operate municipal water systems, which results in interrupted provision and unsafe-to-drink water. Decentralization may also fail to improve public services if elite capture is more significant at the local than at the national level (Bardhan and Mookherjee 2000). Weak local government leadership may also prevent good governance of decentralized services (von Luebke 2009). Decentralization needs political competition and strong institutions to hold local governments accountable to their constituents, reduce local elite capture, and thus improve public services (Bardhan and Mookherjee 2006; Eckardt 2008). Thus, the benefits of decentralization may be partially impeded in developing countries, where political institutions and leadership are often weak or corrupt.

Private Water Services

From a theoretical perspective, markets are efficient in supplying private goods in the absence of externalities, asymmetric information, and monopolistic practices. However, these imperfections are often present in water markets. Regardless of these imperfections, privatization of water services (with appropriate regulation) has been deemed a viable means to introduce competition and improve efficiency in the water sector. More importantly, due to its profit-maximization incentives, the private sector is expected to increasingly invest in infrastructure and thus increase access to improved water services (Hall, Lobina, and de la Motte 2005). However, existing empirical evidence on the performance of private water utilities does not always support theoretical expectations. For instance, Chong and López-de-Silanes (2004) reported improvements in profitability, operating efficiency, investments, and access to water after privatization of some water utilities in Argentina, Bolivia, Brazil, Chile, Colombia, Mexico, and Peru. In contrast, Prasad (2006) argued that private utilities are no more efficient in delivering services than the public sector. Budds and McGranahan (2003) also argued that private water utilities in developing countries (for example, Bolivia and Trinidad and Tobago) perform poorly.

Less contradictory is the fact that water tariffs increase after privatization. Budds and McGranahan (2003) reported that water tariffs increased by as much as 200 percent after water services were privatized in Cochabamba, Bolivia. Given that increases in water tariffs may have a regressive welfare effect on low-income households (Israel 2007), initiatives to privatize water services have sparked public resistance worldwide (see Hall, Lobina, and de la Motte 2005). Martimort and Straub (2009) indicated that public discontent with privatized water services is also associated with changes in the degree and pattern of corruption derived from privatization processes (that is, privatization is often perceived as transferring profitable state-owned companies to the ruling elite). In some cases, public discontent with privatization of the water supply has reached levels high enough to cause water services to revert to the public sector (see, for example, Budds and McGranahan 2003).

Community-Managed Water Services

Community participation in planning, designing, managing, delivering, monitoring, and evaluating services has been deemed a critical component for local development (Bovaird 2007). It is becoming increasingly common to observe community organizations managing and delivering water services to their communities, particularly in rural areas where public and private utilities have failed to provide drinking water. In a community-managed system, water consumers are also water suppliers, often required to provide voluntary inputs for system operation and infrastructure maintenance. They may also be required to participate as committee members, performing such tasks as collecting water fees and undertaking organizational endeavors. This dual role imposes additional costs that do not exist in other forms of service governance (for example, municipal and private utilities). Moreover, Goetz and Gaventa (2001) argued that implementation of community-managed systems is not always responsive to community preferences; oftentimes, community management is a condition that government agencies and nongovernmental organizations impose when they invest in the communities' water infrastructure.

In a recent evaluation of community-managed systems in Bolivia, Peru, and Ghana, Whittington et al. (2009) found that many community-managed systems were operational, particularly when supported with technical assistance. Yet, similar to local governments, communities may lack the technical, financial, and administrative capacities needed to operate and maintain water systems. In addition, as Harvey and Reed (2007) noted, the sustainability of community-managed systems may be jeopardized by community fatigue in providing voluntary inputs, by mobility of community leaders, and by distrust in the community organization responsible for managing the system (presumably due to lack of transparency, accountability, and regulation). The sustainability of community-managed systems is also at risk due to low water tariffs, low user compliance, and lack of financial resources to repair water infrastructure (Sansom 2006; Whittington et al. 2009). Under these circumstances, water infrastructure may fall into disrepair and community-managed systems may provide poorer services than other providers.

3. WATER SERVICES IN RURAL GUATEMALA

In Guatemala, municipal, private, and community-managed utilities supply drinking water under a fragmented legal framework that does not assign clear functions and responsibilities to the multiple agencies managing water resources (Ballestero et al. 2005). The municipal code decentralizes the governance of water services to the municipal level, and the health code assigns regulatory and supervisory functions to the Ministry of Public Health and Social Assistance. The current legal framework does not provide regulations on service standards and enforcement mechanisms for reliable provision of safe drinking water (Vásquez 2011).

Table 3.1—Coverage of water services

Water system =	Private	Municipal	Community-managed	No piped water
National (n = 13,686)	5.8%	40.9%	26.8%	26.5%
Urban (n = 5,808)	6.1%	73.6%	10.2%	10.2%
Rural (n = 7,878)	5.6%	16.8%	39.1%	38.6%

Source: These indicators were calculated using ENCOVI 2006.

Although gradually increasing, access to improved water services still remains a primary concern, particularly in rural areas. Approximately 73.5 percent of Guatemalan households have access to piped water (see Table 3.1). However, drinking water is not equally distributed in the country, with rural households at a substantial disadvantage relative to urban households (62.4 percent versus 89.8 percent, respectively). Table 3.1 also shows that there are differences in the types of water utilities providing water to urban and rural households. Municipalities are the primary supplier of drinking water in urban areas, reaching almost 74 percent of urban households. This is consistent with the current water legislation that assigns the responsibility of providing drinking water to municipalities. Conversely, municipalities have not undertaken their responsibility of providing water to rural areas, where less than 17 percent of households receive municipal water services. These figures suggest that municipalities tend to use their (limited) resources to favor urban households to the detriment of rural areas. As a response, an increasing number of rural communities have implemented their own systems, to the extent that those systems are the main rural water source, serving almost 40 percent of rural households. Private utilities are relatively small and serve a low percentage of both urban and rural households (about 6 percent), mainly those located in gated communities (Lentini 2010).

Table 3.2—Monthly water bill and system reliability

Water system =	Municipal		Private		Community-managed	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Monthly water bill (in GTQ)	12.48	15.23	18.49	34.47	7.89	14.08
Days per month without water	5.24	7.61	4.28	6.96	4.84	7.28
Daily hours without water	7.64	9.53	5.35	8.86	6.72	9.25

Source: These indicators were calculated using ENCOVI 2006.
Note: GTQ = Guatemalan quetzals.

Most water utilities show budget deficits, given that current water tariffs are often insufficient for cost recovery (ESA Consultores 2005). For instance, while households pay US\$0.25[2] to \$2.00 for 30 cubic meters of water, the full cost of supplying water in Guatemala City is estimated to be \$0.25 to \$0.30 per cubic meter of water (IARNA 2005). Water tariffs are kept below the full cost of supplying water because increases in water tariffs are not popular (Galindo and Molina 2007; Lentini 2010). The average monthly water bill varies across different types of water utilities (see Table 3.2). Rural households with private water services report the highest water bills, consistent with profit-maximization incentives of private utilities. Private services are about 50 percent more expensive than municipal services and more than twice as expensive as community-managed ones, which show the lowest monthly water bill. As Vásquez (2011) and Whittington et al. (2009) have argued, low revenues may compromise the reliability and sustainability of water systems.

Table 3.2 also shows indicators of the unreliability of water systems. Private water systems are more reliable than municipal and community-managed systems. Similar to private systems, community-managed services are interrupted on more than four days per month. However, interruptions of water service last about 1.4 hours more in areas served by community-managed systems than in places with private supply ($t = 2.99$, $p < 0.01$). Municipal water systems provide the most unreliable service, with interruptions of about one day per month more than private systems experience ($t = 2.44$, $p < 0.01$). When measured by daily hours without water, municipal systems are also found to be more unreliable than private ($t = 4.58$, $p < 0.01$) and community-managed systems ($t = 2.95$, $p < 0.01$). PAHO (2001), Galindo and Molina (2007), and IARNA (2005) also report frequent interruptions and rationing of water services. Given the differences among municipal, private, and community-managed systems, it may be expected that households assign different values to piped water depending on the type of water utility providing the service.

[2] All dollar amounts are in U.S. dollars.

4. ECONOMETRIC MODELING

The hedonic pricing method treats any good as a tied package of separable characteristics (Rosen 1974). Under the assumption that housing units are packages of amenities supplied at or near the home, the hedonic pricing method has been used to estimate the value that households assign to water services in developing countries (for example, see Nauges, Strand, and Walker 2009; Yusuf and Koundouri 2005). The hedonic models here estimated follow a log-linear form:

$$LNRENT_i = X_i^{'}\beta_i + \sum_{j=1}^{n}\varphi_j w_{ij} + \varepsilon_i \ , \tag{1}$$

where *LNRENT* is the natural logarithm of rental prices, X is a vector of housing characteristics and services other than water (for example, electricity and sanitation), the set of n dummy variables w represent the type of water system to which the housing unit is connected (for example, municipal, private, or community-managed water services), β and φ are conformable vectors of relevant coefficients to be estimated, and ε is the stochastic error term.

The φ coefficients in equation (1) can suffer from endogeneity bias given that households may simultaneously choose the rental price and the type of water service. This would make the choice of water service endogenous through its correlation with unobserved characteristics depicted by the error term (that is, corr(φ_j, ε) $\neq 0$). Households with a higher willingness to pay for water services may have chosen houses connected to a specific type of service, thus leaving households with lower willingness to pay living in houses connected to other service types or in houses without piped water (Nauges, Strand, and Walker 2009). As a result, the estimated value of water services can be overestimated. To address this endogeneity issue, the rental values (that is, $LNRENT_i$) and the choice of water services should be simultaneously modeled.

To model the choice of water services, household i is assumed to derive utility from water service j (V^*_{ij}) as follows:

$$V_{ij}^{*} = Z_i^{'}\alpha_j + \delta_j l_{ij} + u_{ij} \ , \tag{2}$$

where Z is a vector of household characteristics, α is the vector of corresponding parameters to be estimated, and u is the error term. Each choice is assumed to be affected by a unique latent factor (that is, l_{ij}), and the coefficients δ_j are restricted to be equal to one in order to normalize the scale of each choice equation.[3] The indirect utility V^*_{ij} is not directly observed, but it can be uncovered through observed choices in the form of binary variables (that is, w_{ij}). The probability of choosing a given water service is modeled using a mixed multinomial logit formulation (see Deb and Trivedi 2006).

In order to account for the endogeneity of the choice of water services, the error term of rental price equation (1), ε, is assumed to follow this structure:

$$\varepsilon_i = \sum_{j=1}^{n}\lambda_j l_{ij} + e_i \ , \tag{3}$$

where e is the stochastic error term, assumed to follow a normal distribution. This implies that rental prices are a function of the latent factors l that also affect the choice of water services (that is, l_{ij}). Hence, rental prices and the water service choice are correlated through the latent factors and thus need to be estimated simultaneously. The simultaneous equation system is estimated using a maximum simulated likelihood approach with 200 simulation draws per observation.[4]

[3] Deb and Trivedi (2006) indicated that unrestricted estimation of parameters α requires the scale of each choice equation in (2) to be normalized and the covariance between errors u_{ij} to be fixed. The latter is achieved by assuming that each choice is affected by a unique latent factor (see Maddala 1983 for more details).

[4] The model was estimated using *mtreatreg*, a Stata command created by Partha Deb at Hunter College.

5. VARIABLES AND HYPOTHESIS

The data used in this study come from Guatemala's 2006 Living Standards Measurement Survey, referred to as *Encuesta Nacional de Condiciones de Vida* 2006 (ENCOVI). ENCOVI followed a two-stage sampling design. The country was initially divided into rural and urban areas in 22 departments, for a total of 44 areas. The first stage consisted of a stratified sampling procedure implemented at the area level. Primary sampling units in rural areas were classified into four strata using indicators of unsatisfied basic needs: low, medium, medium high, and high. In the second stage, two secondary sampling units (SSUs) consisting of clusters of an average of six households were selected. The first SSU was randomly selected, and the second SSU was systematically selected. This sample is representative of rural households at both national and departmental levels.

A total of 7,878 rural households provided information on structural characteristics of housing units and access to water, sanitation, electricity, and telephone services. Those households that reported having access to piped water also identified the type of water utility (that is, municipal, private, or community-managed service). Out of the 7,878 sampled households, 212 households rented their home. The other 7,666 households either self-owned or occupied their home. These households were asked to assess how much they would pay per month if they had to rent their home. Following Yusuf and Koundouri (2005), the simultaneous hedonic models are estimated using the subsample of households reporting an imputed monthly rent, since some inconsistencies between actual and imputed rental prices may exist.[5]

Table 5.1 presents the definitions and descriptive statistics of the variables used in the hedonic analysis of rental prices. The dummy variables WATMUNI, WATPRIV, and WATCOM are used to estimate the effect of the corresponding water services (municipal, private, and community-managed, respectively) on rental prices. The dummy variables SANIT, ELECT, and PHONE represent household access to sanitation, electricity, and telephone services, respectively. The imputed rent is expected to increase with access to these services. Structural characteristics of the house are also expected to influence the imputed rent. The variables that represent structural characteristics are WALL, ROOF, FLOOR, KITCHEN, and ROOMS. Additionally, some household characteristics are included to control for potential heterogeneity of households. Specifically, HHSIZE (household size), EXTPOOR (extremely poor), and POOR (poor) are included because the demand for housing may increase with household size (that is, $\beta_{\text{HHSIZE}} > 0$) and may decrease with poverty (that is, $\beta_{\text{EXTPOOR}} < 0$ and $\beta_{\text{POOR}} < 0$). Along with HHSIZE, EXTPOOR, and POOR, the variables EDUC, AGE, FEMALE (education, age, and gender of household head, respectively), and SPANISH (primary household language) are used as identifying instruments that affect only the choice of water services.

In addition to estimating the value of water services, three specific hypotheses are tested here (against the null of no effects):

H_1: $\varphi_{\text{WATMUNI}} > 0$

H_2: $\varphi_{\text{WATPRIV}} > 0$

H_3: $\varphi_{\text{WATCOM}} > 0$

[5] The average imputed rent was slightly lower than the average observed rent (GTQ 270.53 versus GTQ 292.60); the difference, however, is not statistically significant ($t = 0.786$). In contrast, an F test (0.346) indicates that imputed rental prices show a greater standard deviation than observed rents (GTQ 406.93 versus GTQ 239.40).

Table 5.1—Variable definitions and descriptive statistics (n = 7,666)

Variable	Definition	Mean	S.D.
LNRENT	Natural log of the imputed rent	5.243	0.825
WATMUNI	If the house is connected to municipal water system (1 = Yes, 0 = Otherwise)	0.162	0.368
WATPRIV	If the house is connected to private water system (1 = Yes, 0 = Otherwise)	0.055	0.228
WATCOM	If the house is connected to community-managed water system (1 = Yes, 0 = Otherwise)	0.393	0.488
SANIT	If the house is connected to drainage system (1 = Yes, 0 = Otherwise)	0.104	0.306
ELECT	If the house is connected to electrical system (1 = Yes, 0 = Otherwise)	0.705	0.456
PHONE	If the house is connected to landline telephone (1 = Yes, 0 = Otherwise)	0.044	0.204
WALL	If wall material is brick, block, or cement (1 = Yes, 0 = Otherwise)	0.360	0.480
ROOF	If roof material is concrete (1 = Yes, 0 = Otherwise)	0.031	0.172
FLOOR	If floor material is tiles (1 = Yes, 0 = Otherwise)	0.119	0.323
KITCHEN	If the house has a dedicated kitchen room (1 = Yes, 0 = Otherwise)	0.537	0.499
ROOMS	Number of rooms in the house	1.983	1.207
HHSIZE	Number of household members	5.392	2.606
EXTPOOR	If the household is extremely poor (1 = Yes, 0 = Otherwise)	0.168	0.374
POOR	If the household is poor (1 = Yes, 0 = Otherwise)	0.426	0.495
EDUC	Education of household head (in years of schooling)	2.574	3.157
AGE	Age of household head (in years)	45.624	15.944
FEMALE	Sex of household head (1 = Female, 0 = Male)	0.191	0.393
SPANISH	If the primary language spoken at home is Spanish (1 = Yes, 0 = Otherwise)	0.719	0.449

Source: Author's calculations.

Given the multiple benefits that households derive from access to piped water (for example, health improvements and released time), access to piped water is expected to increase rental prices of housing units regardless of the type of water utility (municipal, private, or community-managed), as stated in hypotheses H_1, H_2, and H_3. However, the value that households assign to water services may vary across different types of utilities depending on system performance, given that system unreliability may impose implicit costs on households (Baisa et al. 2010). As shown in Table 3.2, in rural Guatemala, private systems are the most reliable, followed by community-managed and municipal systems, respectively. Thus, the following hypothesis is tested under the assumption that the values households assign to water services reflect the reliability of the water systems (see Vásquez et al. 2009):

H_4: VALUEPRIVATE > $\text{VALUE}_{\text{COMMUNITY}}$ > $\text{VALUE}_{\text{MUNICIPAL}}$

According to hypothesis H_4, rural households prefer private water services over community-managed and municipal water provisions. This hypothesis is consistent with the reliability of water systems under corresponding types of service management.

6. ESTIMATED HEDONIC MODELS

Table 6.1 presents the hedonic models used in this study to estimate the value of rural water services. Model 1 controls for market heterogeneity at the department (state) level by including a dummy variable for each of the 22 departments in Guatemala. Model 2 does not include departmental dummy variables. The Akaike information criterion (AIC) and Bayesian information criterion (BIC) indicate that model 1, the model controlling for departmental effects, should perform better than model 2. Estimation results show a considerable degree of robustness across model specifications but some differences in estimated value of water services.

Table 6.1—Hedonic Models

	Model 1	**Model 2**
WATMUNI	0.218 (0.058)***	0.247 (0.054)***
WATPRIV	0.150 (0.127)	0.186 (0.111)*
WATCOM	-0.262 (0.060)***	-0.337 (0.041)***
SANIT	0.118 (0.026)***	0.154 (0.027)***
ELECT	0.173 (0.019)***	0.175 (0.019)***
PHONE	0.282 (0.041)***	0.267 (0.042)***
WALL	0.187 (0.018)***	0.208 (0.018)***
ROOF	0.339 (0.050)***	0.320 (0.049)***
FLOOR	0.125 (0.027)***	0.134 (0.027)***
KITCHEN	0.050 (0.016)***	0.055 (0.015)***
ROOMS	0.116 (0.009)***	0.108 (0.009)***
HHSIZE	0.046 (0.004)***	0.049 (0.004)***
EXTPOOR	-0.701 (0.029)***	-0.741 (0.028)***
POOR	-0.350 (0.020)***	-0.373 (0.020)***
CONSTANT	5.032 (0.085)***	4.849 (0.044)***
Departmental (fixed) effects	Yes	No
Observations	7,666	7,666
AIC	32,911.5	33,084.6
BIC	33,355.0	33,383.2
LR test for exogeneity ($\chi^2_{df=3}$)	46.8***	74.5***

Source: Author's calculations.
Notes: ***, **, * imply significance at 1%, 5%, and 10% levels respectively; numbers in parentheses are corresponding robust standard errors. Instruments: Household size, extreme poverty, poverty, main language spoken at home, and household head's education, age, and sex. χ^2 tests support the validity of these instruments.

Consistent with hypothesis H_1, estimated coefficients on WATMUNI are positive and significant in both models, implying that households in rural areas value municipal water services. Estache, Foster, and Wodon (2002) and Yusuf and Koundouri (2005) presented similar results in terms of positive values for water services from Honduras and Indonesia, respectively. These studies, however, did not consider differences in the value that households assign to piped water under different forms of service management. Estimated models provide evidence indicating that households assign different values to municipal, private, and community-managed services. Estimated coefficients on WATPRIV are significant only in model 2 (at the 10 percent level). This evidence is inconclusive to support hypothesis H_2, that private water services are valued and consequently increase rental prices in rural areas. Moreover, estimated coefficients on WATCOM are negative and significant across both models, suggesting that households have an aversion to community-managed water services, in contradiction to hypothesis H_3. This result is unexpected given that community-managed systems are the primary form of water provision in rural areas of Guatemala.

As expected, findings also indicate that rental prices increase with access to sanitation, electricity, and telephone services. All structural attributes also affect rental prices. Estimated coefficients on WALL, ROOF, FLOOR, and ROOMS indicate that households are willing to pay a higher rent for housing units that are built with better materials and have a larger number of rooms. Households are also willing to pay more for housing units with a dedicated kitchen room as indicated by positive coefficients of KITCHEN. In addition, estimated coefficients on HHSIZE suggest that household size has a positive impact on rental prices. In contrast, poor and extremely poor households show a lower willingness to pay for housing than nonpoor households, as suggested by the negative sign of the corresponding coefficients. These results provide evidence of the validity of the hedonic models here estimated to investigate household preferences for different types of water service management. As further evidence of the validity of our hedonic models, likelihood ratio tests reject the hypothesis that the choice of water service is exogenous to the hedonic models. This implies that the simultaneous modeling strategy implemented in this study is appropriate given the endogeneity of household choices of water services and thus provides unbiased estimates of the value of water services.

Table 6.2—Estimated value of water services

Water system =	Municipal	Private	Community-managed
Model 1			
Estimated value	66.07	43.93	-62.44
Estimated value in relation to water bill (%)	525.0%	239.2%	-801.3%
95% CI lower bound	29.68	-26.45	-85.49
95% CI upper bound	106.06	134.31	-35.87
Model 2			
Estimated value	75.73	55.32	-77.35
Estimated value in relation to water bill (%)	601.6%	301.3%	-999.5%
95% CI lower bound	39.69	-7.23	-92.54
95% CI upper bound	114.27	135.81	-60.94

Source: Author's calculations.
Note: 95% CI is derived using the Krinsky and Robb (1986) procedure (using 5,000 simulations).

The marginal effects of the dummy variables WATMUNI, WATPRIV, and WATCOM provide an estimate of the value assigned to the corresponding water services. Given that the hedonic models follow a semilogarithmic specification and that water variables are binary, the marginal effects of those variables can be estimated as $(e^{\varphi j}-1)R$, where j stands for private, municipal, or community-managed water services; φ is the corresponding coefficient estimated in the hedonic models; and R represents the average monthly rent (see Halvorsen and Palmquist 1980). Table 6.2 presents estimates of those values with corresponding 95 percent confidence intervals calculated using Krinsky and Robb's (1986) bootstrapping procedure (with 5,000 simulations). The estimated values are also compared with the average monthly water bill for the corresponding service.

Estimates based on model 1 indicate that the value that rural households assign to municipal water services is equivalent to GTQ 66.07 (Guatemalan quetzals, about \$8.52), five times as much as the average monthly bill (see Table 6.2). This estimate is in the lower range of values reported by Nauges, Strand, and Walker (2009) from marginal barrios in four Guatemalan cities (\$5–\$65). For private services, the value estimated is GTQ 43.93, but it is not statistically significant. Table 6.2 also shows negative values for community-managed services, which suggest that households prefer not having piped water over being connected to a community-managed system. These results contradict hypothesis H_4, that households would show a higher willingness to pay for more reliable services.

Table 6.3—Tests of median value differentials

Hypothesis H_4	Model 1	Model 2
$P(VALUE_{PRIVATE} > VALUE_{COMMUNITY})$	0.999981	1
$P(VALUE_{PRIVATE} > VALUE_{MUNICIPAL})$	0.001046	0.002083
$P(VALUE_{COMMUNITY} > VALUE_{MUNICIPAL})$	0	0

Source: Author's calculations.

Table 6.3 presents formal tests of hypothesis H_4 based on the complete combinatorial approach of Poe, Giraud, and Loomis (2005). This approach was demonstrated to yield probabilities analogous to conventional p-values for hypothesis testing.[6] In support of hypothesis H_4, the value that households assign to piped water provided by private utilities is higher than the value estimated for community-managed services. This is consistent with the fact that private systems are more reliable than community-managed systems. However, contrary to hypothesis H_4, households are not willing to pay more for private and community-managed services than for municipal services. In contrast, rural households assign a higher value to municipal water services than to the other types. Value differentials across these forms of service governance are all statistically significant (at the one percent level). This suggests that system reliability is not the only characteristic that affects household preferences for different approaches to water service governance. There are other factors that could influence the value that households assign to water services, such as water tariffs and institutional costs.

[6] See Vásquez et al. (2009); Vásquez, Franceschi, and Van Hecken (2011); and Carlsson, Frykblom, and Lagerkvist (2007) for recent applications of Poe, Giraud, and Loomis's (2005) combinatorial approach to test statistical significance across distributions of willingness-to-pay estimates.

7. DISCUSSION AND POLICY IMPLICATIONS

This paper investigated household preferences for water service governance approaches by estimating the value that households assign to municipal, private, and community-managed services in Guatemala. Economic values for water services were derived through hedonic models of imputed housing rental prices. Hence, estimated values can be interpreted as households' willingness to pay for a given type of water service. Overall, value estimates point to strong preferences for municipal services in rural areas. In contrast, results indicate that households are indifferent between not having access to piped water and being connected to a privately-managed system. Furthermore, rural households seem to have an aversion to community-managed services, as indicated by negative value estimates.

From a utilitarian perspective, households may be expected to value piped water based on the reliability of water services regardless of the type of service governance. Under this premise, value estimates for private services would be higher than the value assigned to community-managed and municipal services, given that private systems are more reliable. Moreover, municipal services would show the lowest value, given their unreliability. However, estimated values are contrary to those expectations, suggesting that there are factors other than system reliability that influence household preferences for water services. For instance, high water tariffs could partially explain the indifference of households regarding private services, since higher water bills decrease disposable income for other goods, thus offsetting the benefits drawn from access to piped water. That could also partially explain the fact that municipal water supplies were the most highly valued. That is, municipal services may be deemed a more balanced alternative in terms of system reliability and water tariffs. This presumption, however, suggests that water demand is elastic, in clear contradiction to existing empirical evidence from developing countries (see Nauges and Whittington 2010). In addition, community-managed services show lower water bills and reliability indicators that are comparable to those of private services. Yet households assigned negative values to community-managed water services.

Institutional cost differentials can provide a more plausible explanation for estimated values. In community-managed water systems, water consumers are also suppliers and are required to contribute voluntary inputs to the operation and maintenance of the system. These systems may also negatively impact relations among community members (Harvey and Reed 2007). Distrust in the community organization responsible for managing the system and low user compliance may arise due to absence of appropriate regulation, which seems to be the case in Guatemala (see Vásquez 2011). These institutional costs, which are not present in municipal and private systems, may influence the value that households assigned to community-managed water services. The value assigned to private services can also be related to the corresponding institutional framework. More specifically, in the absence of regulation and supervision, private utilities may adopt monopolistic practices such as charging higher tariffs. Unprotected consumers would then prefer not to be connected to a private system (see Budds and McGranahan 2003; Hall, Lobina, and de la Motte 2005). In the case of municipal services, even in the absence of regulation, water consumers still have their vote to eventually change the system administration if they are dissatisfied with the quality of water services. Hence, households would prefer municipal over private or community management.

Current household preferences further the legitimacy of municipalities in requesting more resources from the central government to extend water infrastructure to rural areas (see Rodríguez-Pose, Tijmstra, and Bwire 2009). This is particularly important for rural Guatemala given the large percentage of households that still lack access to piped water. Moreover, municipalities could consider increasing water fees to cover operation and maintenance costs. On the other hand, the rejection of community-managed systems raises some concerns given their service coverage in rural areas. Household preferences against community-managed services may reflect some community fatigue in providing the labor and other inputs required of households for operating and maintaining the system. In that case, community-managed systems would benefit if offered technical and managerial assistance from the central or municipal government in order to improve the quality of their water supply. More importantly, such assistance would reduce the amount of voluntary inputs needed to operate the system and to prevent water infrastructure from falling into disrepair (Harvey and Reed 2007; Whittington et al. 2009). The analysis of factors underlying household preferences against community-managed systems deserves more attention given the prevalence of those systems in rural areas, where many households are still to be provided with piped water.

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